

# I. EXTERIOR MATERIALS

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## A. CONCRETE

### 1) Background

The footing and foundation walls of the building are made of reinforced concrete. The tops of the walls, with few exceptions, are either protected below grade or sheathed with protecting granite. The concrete below grade is covered with a bituminous, water-resisting coating.

### 2) Analysis

As a result of the aforementioned protections, together with the adequacy of the structural design, no significant cracking is apparent, nor is there significant spalling.

On the westernmost section of the north wall, a small portion of foundation wall is exposed. This area shows the joint between the top of the concrete foundation and the stone wall above. In between these is a bed of mortar and horizontal pieces of clay tile. This unexpected detail seems to be a leveling course, perhaps to allow the original masons to compensate for slight variations in the dimensions of the stone or levelness of the top of the foundation wall. Although unprotected, this small area is far enough above grade that little if any water penetration occurs.

The concrete foundation walls under the bases of the stone sidewall flanking the east and west stairways is newly repaired and in good condition. There is no exposed concrete work in the upper sections of the building.

### 3) Recommendations

As mentioned in section 1. above, grade the earth to slope away from the base of the foundation. When the moat is built and the concrete foundation walls are exposed, apply new water-resistant membrane on all areas of the wall where the membrane is missing or has cracked, peeled or otherwise failed. This will protect the basement from any water which may enter the moat. If the moat is covered by a waterproof roof, this re-sealing of the existing walls need not be done.

Where any other exposed concrete is cracked, spalled or damaged, repair it with matching concrete and detail the joints and finish to discourage the penetration of water.





## B. STONE

### 1) Background

The exterior walls, columns and lower level ornament of the Capitol are constructed of carved quartzite or granite quarried from the same Big Cottonwood Canyon site that produced stone for the Salt Lake Temple of 1853-93. Photos exist of the large single slabs of quartz monzonite or “Temple” granite being taken from the quarry and cut, lathe-carved and chiseled into the architectural shapes and profiles needed for the project. Stone specialists familiar with the quarry say the stone in the front section of the quarry is softer than that in the rear section. Assuming the quarry was worked from front to back, i.e., lower to higher, then stone for buildings such as the Salt Lake LDS Temple would have come from the lower or front part of the quarry, while stone for the Capitol and other later structures would have come from the upper section where the stone was of

higher quality.

The original Capitol Commission spent considerable time and effort traveling throughout Utah and the United States examining various options for the building’s exterior and interior stone (see details in the History section of this report). They debated at length whether the exterior columns should be monolithic and polished (as they are in the interior rotunda), or sectional and chisel-finished. After input from project architect R.K.A. Kletting and two local associations of architects, the Commission selected the sectional, chiseled columns.

The measured as-built exterior elevation drawings prepared for this report show each stone in the building, and the exterior elements surveys indicate the presence of cracking, staining, missing mortar and other masonry problems. The exterior survey sheets, including photos, are found in the Appendix of this report.



### 2) Analysis

Overall, the granite itself and its mortar appear to be in good condition. A few pieces of ornament (a piece of baluster and a horizontal cornice element, for example) have cracked and fallen from the building. The damaged pieces show that the interior reinforcing bars had corroded from water damage, expanded, and cracked the stone.

One possibility for this phenomenon is that a few leaks in the roof and flashing have allowed water to reach only a

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limited number of individual stones and their reinforcing bars which are now vulnerable to failure. The presence of metal staining on the sides and undersides of such pieces may be an indicator of potential failure, breakage and failing stone. A more serious possibility is that large quantities of stone units have gotten damp enough over the years to cause extensive damage in multiple locations. How extensive this type of damage is throughout the system of exterior masonry cannot be known until physical tests are completed.

Even while the Capitol was under construction, architect Kletting wrote letters to the building contractor complaining about masonry problems. One letter dated May 13, 1915 states,

*I find that you are not securing the bead on outer edges of all flashed cornices as specified and shown on drawings. Your failure to do this has caused one piece of east pediment to blow off.*

On June 2, 1915, Kletting wrote that,

*It appears that either the copper roofing or the terra-cotta roofing of the dome or both are not waterproof. In fact, during the heavy rain on yesterday afternoon these roofs leaked all over to an alarming extent. Please have this rectified at once in order to prevent further damage.*

Apparently the problems were not rectified to Kletting's satisfaction, for he wrote again exactly two weeks later that,

*Some time ago I was on the building and noticed that the dome was leaking through the concrete wall above the bottom steel ring which supports the ribs of the dome. We paid you (the contractor) an extra for waterproofing this concrete on the outside and had it been properly done, there could not have been any leak. I also find that the top course above does not cover the back rib of the former as detailed. Very likely this is where the water is coming through. This matter must be taken care of at once, as any further leaks might damage the interior decoration, etc. which will mean further expense to you.*

What Kletting did not mention was that for the water to reach the interior, it had to first pass through the structure of the roof and walls. Whether the dampening of the masonry and its reinforcing bars during construction caused hidden internal damage then, or whether the damage occurred due to later leaks, or both, has not yet been determined. Kletting's letters addressed both leakage around the dome, which affected mostly the interior, and leakage at the parapets, which would impact the perimeter ornamental stone. Re-roofers in the 1990s reported evidence of major roofing damage and leaking throughout the roof system.

A report prepared in September, 1995 entitled "Technical Report Regarding Deterioration Causes, Effects and Solutions, The State Capitol Building," concluded that,

*The general condition of the Utah State Capitol may be defined as being in a severe state of deterioration. Proper analysis of deterioration should always begin with a question of cause and effect. The most natural form of deterioration is produced over time by what we may identify as environment effects. These situations may still lead to more serious deteriorations in the future. Such results are however ... may be regarded as anticipated. While the Utah State Capitol does exhibit signs of "normal" deterioration in many areas, the structure also is replete in a much more serious type of deterioration: corrosion.*



The report goes on to describe the effects of corrosion on the granite, as well as exterior terra cotta and concrete. In addition to the rusting of metal anchoring bars already mentioned, there is also evidence of the spalling of the surface of about 5% of the granite units, particularly on the lowest parts of the exterior, and on the south elevation where the effects of weathering are most severe. One stone expert speculates that the stone here may be of poorer quality (softer) than elsewhere, and thus more vulnerable to the forces of nature.

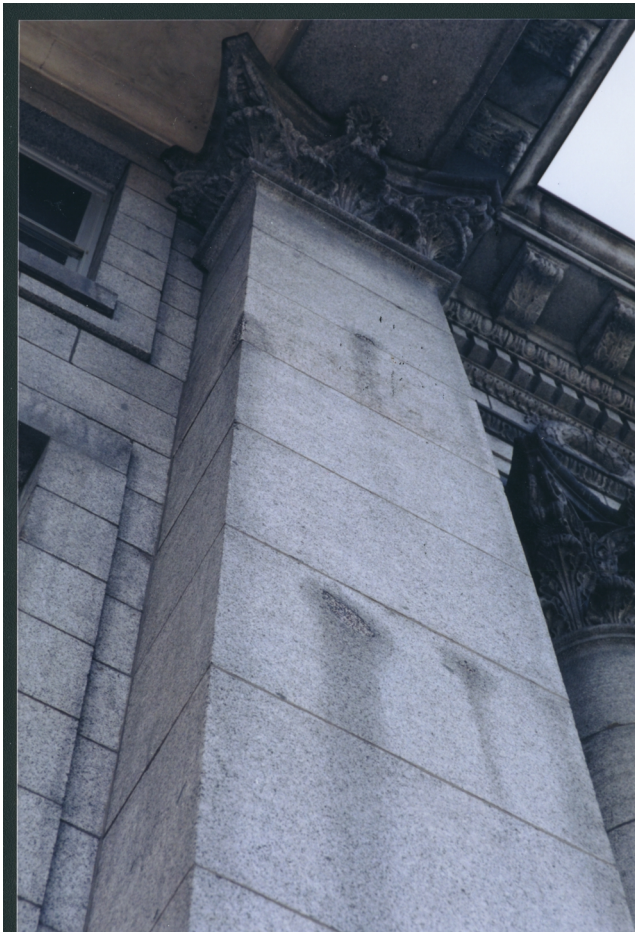


Some of the spalling appears due to the intrusion of water from rain, snow, and perhaps sheeting down the surface of the walls. As the water enters the porous cavities of the surface of the stone, it freezes and thaws during alternately cold and slightly warmer weather. As the water freezes, it expands and causes stresses within the stone that result in cracking, chipping or flaking of the stone in layers parallel to its surface.

Maintenance personnel believe that the spalling on the vertical surfaces of the column bases at the south entry has been caused by chemicals in the solutions used to clean or melt snow on the landing. Stone consultants confer that this is a likely possibility, since spalling does not appear to have occurred on similar vertical surfaces where cleaning and melting solutions have not been used.

In addition to this observable spalling or exfoliation, freezing and spalling has cracked the mortar in the joints between the stone units. Some of the mortar has fallen out of the joints, making it increasingly easy for water to enter the masonry and cause even greater damage.

The exterior stone contains both dark and light spots on its surface, both of which contrast from the variations of gray which constitute the primary stone coloration. The white spots are patches which were added after shaping the stone to fill naturally occurring holes. The patches appear to be cementitious with lime, or whitening, and a light aggregate which gives them their light color. The patches are problematic for two reasons. First, their white color distracts visually from the variegated gray color harmony of the stone. Secondly, visible, dark stains are leaching from the patches down the surface of the stone. This is particularly apparent on the columns. The stains may be from pollution adhering to a silicone-based sealant applied to the more absorbent patches to protect them from water. While invisible when first applied, the sealant has since attracted pollution to its sticky surface, causing the unsightly staining.





The dark gray or black spots are “inclusions” or xenoliths of unmelted gneiss material naturally embedded in the overall stone. The faces of the inclusions have been stippled by masons to expose the lighter aggregate within so as to tone down the darkness to better blend in with the lighter surface texture of the surrounding stone. However, like the patches, visible stains surround some of the inclusions. It is not known whether the staining occurred and then stopped early in the building’s history, or whether the staining process is still active. Or, again, the stains may be the result of applying a silicone-based sealant which has attracted pollution.

In addition to the stains associated with the patches and inclusions, there are stains of various colors, thicknesses and patterns on many other masonry surfaces. These are documented on our exterior materials survey forms.

To date, none of the stains, whether from patches and inclusions, or general surface staining, have been tested to determine their chemical characteristics and origins. Much of the gray surface staining is typical of the air-born pollutants found on the surfaces of other stone buildings in the city.



The Capitol is situated just east of and downwind from the city’s industrial district and manufacturing district. For decades, air born coal tars, SO<sub>2</sub> from automobiles, and a variety of other pollutants have washed across the face of the building. While coal burning is now rare and many of the old factories on the west side are no longer in operation, the refineries in Swede Town to the northwest may still be allowing chemical pollutants to drift in the direction of the Capitol. Likewise, the chimneys of nearby houses, businesses, schools and hospitals have contributed pollution. The fact that the white Synergy coating applied to the dome’s columns and walls in 1995 is now already badly soiled by pollution suggests that the source of soiling is a continuing problem.

Another type of staining (yellow or reddish-brown) is likely the result of the aforementioned rusting of reinforcing metal in the stonework. Water leaking through the roof, flashing, parapets, or wind-driven into loose or missing mortar joints, may have caused rusting, in soluble form, has leached through the stonework



and deposited itself on exterior stone surfaces. This type of staining is thus more than just a visual problem since it may portend potential structural failure as well.

The surface of the exterior stone does not appear ever to have been cleaned, so 85 years of surface pollution and rust remains. The appearance of the building would be greatly enhanced by cleaning the stone. Removing the soiling would also protect the stone from the adverse chemical reactions caused by the pollutants.

As previously mentioned, a small number of stones have fallen from the building or are chipped or cracked and typically heavily stained,

portending future failure and perhaps falling. Most of the stone in this precarious condition appears to be on the west elevation which seems the most subjected to weathering. Not only is there a danger from falling stone, either with or without a seismic event, but the cracks invite accelerated deterioration due to their allowing additional water, rusting, freezing and thawing and cracking to occur.

### 3) Recommendations:

#### a) Test the Stone

Before attempting to clean and repair the stone, it is advisable to understand the physical properties of the stone and the surface soiling so that cleaning and repairing materials and methods can be custom-designed to solve the problems presented by this specific stone.

The few pieces of stone that have fallen from the building should be tested in a stone analyst's laboratory. The stone should be tested for hardness, strength, and chemical properties including bonding. The mortar can be similarly tested, as can the embedded reinforcing metal and the nature of the surface pollution and staining. Once these characteristics are known, cleaning agents and restoration methods can be devised.

The Capitol Preservation Board has accepted a proposal to conduct additional stone testing and analysis. Among the tests to be done are the following:

- \* Flexural strength
- \* Modulus of rupture
- \* Compressive strength
- \* Absorption/ density
- \* Anchoring (tension and shear)
- \* Petrography (chemical) analysis
- \* Free-thaw cycles

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- \* Stain resistance
  - \* Mortar analysis (compression, composition, gradation)
  - \* Ferrous scans

b) Clean the Stone

Apply mild, non-abrasive, low-pressure cleaning agents to the surface of the granite masonry to return it to its original appearance insofar as possible. For hard-to-remove stains, apply poultices and/or low-pressure washing. Repair any mortar damaged during the cleaning as per 3) below.

c) Tuckpoint the Masonry Joints

At a minimum, we recommend removing loose mortar and tuckpointing all joints that have missing or damaged mortar. The new mortar should exactly match the original in hardness, mixture, texture, color and tooling. Provide test samples for approval prior to repointing.

d) Repair Damaged Stone

Grind out damaged mortar joints to expose underlying, embedded reinforcing metal to view. If the metal connectors have deteriorated, remove the stone, install new, stainless steel connectors embedded in epoxy, and reinstall the stone. If rust stains suggest deterioration which is not visible, conduct ferrous scans to determine if the diameter of the metal has expanded (rusting connectors expand and, like expanding ice, cause cracking). If the evidence suggests deterioration and potential structural failure, restore the stone pieces with new connectors as just described.

e) Repair Spalling

Apply penetrating consolidants to the surface of spalling stone to better bind the surface particles, harden the stone and enhance its water-resisting characteristics. Research available products of companies such as ProSoCo and HMK to determine which are most chemically compatible and potentially effective with the stone.

f) Foundation Grading

We would normally recommend removing some of the causes of weather damage by grading earth away from the foundation of the building. However, in this instance we recommend installing a sloping roof to the “moat” which will surround the perimeter when a base isolation structural system is installed. If installed, the moat will replace the need for regrading. However, the roof of the moat should shed water away from the base of the building.

## C. MORTAR

### 1) Background

Mortar was used in the original construction as the setting or bedding material for units of stone, brick, and

hollow clay tile, the latter two of which are hidden within the building's walls. The original architectural specifications called for "non-staining" cement mixed with lime putty, all with joints thoroughly filled and pointed. Joints shall be neatly bedded with a jointer." The "cement" referred to was undoubtedly Portland cement, which had been available since the mid-1870s. Masonry building erected between the 1870s and 1930 employed mortar that ranged from pure lime putty to pure Portland cement, or some combination of the two.

From samples of the mortar visible on the exterior of the Capitol including the bedding mortar exposed between the concrete foundation wall, clay tile "levelers" and foundation stone seen in the north wall at the west end of the building, the mortar appears to be a light gray-white material which indicates that some lime was used as specified. Some sand and aggregate also is present. The mortar is hard and brittle, indicating the possibility of Portland cement.

Kletting was employing the lime putty cement mortar mixture common to his era. For maximum convenience and workability, it may have been mixed on site using slaked quick lime, sand and water. The exact ratio of these materials in the mortar mix is not presently known. It may have been that Kletting was using Portland cement as the major ingredient, with only a 10-15% lime admixture included by volume. It was a prevailing national theory in 1915 that stronger mortar was better, and thus more cement was used than previously. However, Kletting, an Old World architect before moving to Utah from Germany and France in the early 1880s, may have preferred the earlier mixtures. Without testing, we can only speculate. In any event, the new practice resulted in an "epidemic of leaky masonry" in the following years. By 1930, the pendulum would swing back to lime putty mortar containing about equal amounts of Portland cement and lime putty.

The Capitol's mortar joints are indeed 1/4" wide or less, as originally specified. Most are tooled with a beaded profile which is effective in shedding water away from the joint. A few joints are tooled flush or vertically plumb and flat. The mortar in the sidewalls of the recently renovated stairway appears to be straight Portland cement, although that cannot be said with certainty without either testing or referring to the recently prepared mortar specifications.

## 2) Analysis

The original mortar exposed in the joints between the blocks and pieces of exterior stone remains intact and in excellent condition in nearly all places. We have documented in our exterior survey those locations in which the visible pointing mortar is missing, cracked or otherwise badly damaged.

The purpose of the original mortar was to provide a relatively soft, flexible, self-healing bedding intended to act as a "sacrificial material" allowing the masonry structure to move slightly and forgivingly without cracking. The mortar's strength was lower than that of the stone to allow the masonry walls to "flex" without breaking. This strategy has proven successful, as indicated by the overall lack of significant cracks in either the stone or the mortar. This lack of cracking is also in large part due to the minimal settlement of the structure, which itself is due to adequately engineered and constructed footings and superstructure.

The historic mortar also was breathable. Although the stone masonry, including the mortar, served to keep most water from entering the building due to the mere thickness of the walls, moisture from within the building was designed to escape as vapor through the mortar. This also applies to the small amount of water that was absorbed into the walls from the weather. Water was simply allowed to evaporate from the surface.



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The primary force that acts to damage or destroy mortar is the movement of water through the material, or the freezing of water within the material. Water breaks down the chemical composition of the mortar and freezing action causes expansion which can physically break mortar apart. Physical stresses in the walls typically caused by settling or earthquakes may also cause mortar to crack and/or break apart, making it even more vulnerable to the effects of weathering. A common but improper treatment is to tuckpoint old joints with new, harder mortar such as a mix very high in Portland cement content. Stresses transferred through walls and into hard mortar then can be conveyed into surrounding masonry units, causing the breaking of bonds between the mortar and the units. This may cause cracking of the masonry itself. Because they are denser, hard mortars also are typically less water-permeable and may trap water and water vapor behind them, also contributing to spalling and breaking.

### 3) Recommendations

Test the mortar to determine its compressive strength and physical properties, including the mixture of cement, lime and sand. This information will prove useful in designing the specifications for the repointing mortar.

Wherever masonry joints are missing, damaged or loose, remove said mortar back to solid material and replace it with an exactly matching mortar mixture, as determined by the testing. Do not use a mortar too high in Portland cement content. The repointing mortar should be softer than the stone and no harder than the original mortar so as to prevent damage to the masonry units. As previously noted, stresses in the masonry walls and ornament should be relieved by the mortar rather than the units of stone.

The new mortar also should be as water permeable as the original mortar, which will naturally occur if no vapor-impeding admixtures are included. The color, texture and method of pointing also should match. As mentioned above, the pointing was mostly beaded. The width of any joints in new masonry walls or ornament should match original dimensions.



## D. TERRA COTTA

### 1) Background

Terra cotta on the Capitol is limited to the square base and upper surfaces of the drum beneath the copper-clad dome, as well as to selected details of the drum. The material, with a thin, granitized glaze, was fabricated by Northwest Terra Cotta of Chicago, a company which no longer exists. Terra cotta units include plain ashlar-coursed units, balustrades, capitals, a cornice and, at the uppermost section of the drum just below the copper dome cladding, a ring featuring garlands

and consoles.

Terra cotta is a glazed, fired clay material that was particularly popular as a building material in the United States from 1880 to 1930. Its popularity stemmed from its ability to assume complex forms, while at the same time being fireproof, light weight, and less expensive than stone. Terra cotta was installed using steel anchors to attach the units to the substrate. The corrosion of the anchoring system is always a concern with older terra cotta, especially at cornices, since the failure of the anchorage could result in terra cotta units cracking, breaking and even falling.

The terra cotta was the subject of two studies during the 1990s. The first, from 1991, is “Terra Cotta and Other Masonry Materials, Utah State Capitol, Salt Lake City, Utah,” by Theodore H.M. Prudon. This report summarizes conditions at several locations, and provides limited recommendations, mostly for more testing. At that time, no terra cotta was removed for inspection of fasteners. The report noted that water infiltration at the cornice was causing deterioration of the stucco-clad columns below.



The second, “Technical Report Regarding Deterioration Causes, Effects and Solutions, The State of Utah Capitol Building,” by Jim Hanlon of Cathedral Stone, dates from 1995. This report found cracked, missing and poorly repaired mortar joints; abundant random spalling; scattered patching; stress cracks; and deteriorated glazing. Like the Prudon report, it questioned unit anchorage. While apparently thorough in documenting conditions at time of survey, many of the conclusions and recommendations in this report are questionable.

The terra cotta is also discussed in the August 1995 “Utah State Facilities Evaluation and 20 year Plan of Action” by Eldredge & Nicholson, Architects. This report recommends inspection of the fasteners.

Some temporary repairs were performed in 1995. These included “caulking the terra cotta.” A field report from this repair describes the rationale for this application: “The caulking of the terra cotta is almost complete. The caulking was performed to waterproof the terra

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cotta for only a few years. It is anticipated that in the near future, a permanent solution for the damaged terra cotta will be determined, and the final restoration and/or replacement of the terra cotta will not significantly damage the work accomplished at this time.”

There remains some question as to what was originally intended for the upper exterior walls and features. Architect Richard Kletting’s original specifications for the Capitol include a section on “Artificial Stone,” a product which either was not installed, or was unsuccessful and replaced or covered over with later, newer products. The specification stated that “All the buttresses, Steps, Seats, Brackets, etc., in fact all the work exposed to view shall be concrete having a very hard surface in perfect imitation of the granite used in the main building.”

Kletting called for the artificial stone to be “waterproofed.” While the buttresses could be cast in place, all of the other pieces were to be “cast and cured” in a shop. He required that “all blocks of artificial stone shall be cast at one time without stoppage.” The individual pieces were to be set in place with a “non-staining” cement mixed with lime putty,” and secured with reinforcing iron dowels and rods. He required full size carved models of each piece for review and approval.

Looking at the building as it presently exists, it is not apparent where any pieces of artificial stone fitting this description might exist. One possibility is that Kletting meant this term to apply to the plaster or stucco finish called for on the dome. He does later use the term “artificial stone” in “imitation granite” to refer to what was eventually installed as scored plaster. However, this product was not concrete, nor was it cast in place or otherwise.

The closest modern product approximating “artificial stone” might be cast concrete, sometimes called cast stone. Examples of this product would be the gargoyles and other replacement ornaments put on the Cathedral of the Madeleine when it was renovated in the 1970s and ‘80s. No material of this type is apparent on the Capitol, however. In lieu of such a product, the Capitol features both ornamental terra cotta and plastered surfaces, now covered with modern “Synergy,” on the dome. All ornament beneath the dome level is executed in actual stone.

Two possible explanations for the apparent change might be that either the “artificial stone” was not available in the time and/or quality needed, or, if available, was considered too costly to use. We do know that terra cotta was used for the walls of the base of the dome, as well as for the balustrades between the dome’s columns, and also for the capitals of the columns. It was also used for the features in the tall ornamental band just below the copper dome roof. However, in other locations, such as the round walls of the middle and upper dome, the ornamental window trim in those walls, and the columns and bases of the dome, plaster was used instead.

The question of whether to use plaster or terra cotta for the exterior of the dome was still being debated in mid-1914. On June 12, a meeting of the Capitol Commission was held to discuss a proposal from James Stewart & Company, the general contractor, to:

*Substitute terra cotta in imitation granite in lieu of cement plaster were specified on the exterior of the dome of the roof and skylight of the main building up to the frieze and cornice above the 24 windows including bases and shafts of 24 columns, architrave, and frieze above column caps, making all exterior of the dome terra cotta up to the copper covering of the roof of the dome, for the additional costs of \$43,200.00.*

The proposal was voted on but defeated. A substitute motion was put forward and passed. It provided that



terra cotta be substituted for plaster on the base of the dome only up to the foot of the drum columns, at an additional expenses of \$20,500.00.

A year later, Kletting's June 8, 1915 revised building section through the dome has notes such as "3/8" Detail of Dome Window Showing Artificial Stone Jointing." Another note adjacent to his handwritten signature along the side of the large dome section calls for "All outside finish designated as 'ARTIFICIAL STONE' is to be executed in cement plaster in imitation of granite. See specifications." He does not say which specifications, but presumably he means those entitled "Artificial Stone," which brings us back to the original problem of terminology.

In any event, the material actually applied was cement plaster, scored to resemble stone. None of the original finish is visible, however, and no photographs have been found that show the finish close up. We know that it did not last long in good condition and that it likely contained asbestos. It was covered over at least once and possibly twice, first by a beige coating which did not adhere well; and then in 1985 by the "Synergy" coating and silicone-based sealant which attracted unsightly grime and pollution. Whether the original finish was ever done in "imitation granite" and whether the finish ever really successfully imitated granite to Kletting's satisfaction may never be known. That he preferred a terra cotta veneer and ornament over all surfaces of the dome is clear from the various proposals he had the contractor prepare for review by the Capitol Commission. It appears to be for economic reasons alone that Kletting's design desires an all terra cotta dome were only partly realized.

## 2) Analysis

Most of the terra cotta appears to be in sound condition, with only minor, localized damages. The uppermost portion of the drum just beneath the copper cladding is currently inaccessible, and its terra cotta is believed to be in worse condition than below. Described below are areas of localized damage.

Balustrade caps: minor spalls are the most pervasive damage, probably caused by falling icicles. The sealant described in the field report quoted above – a gray, elastic substance – is applied to horizontal and vertical joints and cracks. Also, many of the raised edges of the horizontal surfaces have spalled off. This detail, commonly used for horizontal surfaces such as window sills and parapet caps, is extremely vulnerable to spalling.

Balusters: blackened areas occur at the inside edges and surfaces at the northwest side of the building. This discoloration seems to be occurring at surfaces most exposed to weather, and may be the result either of soiling or of surface etching. Microscopic analysis of these blackened surfaces would help to determine the cause. Stained and failing mortar joints are also common. Many of the joints between the baluster base and shaft have already lost mortar, while other joints are stained green from copper roofing runoff.

Terra cotta roof tile below upper balustrade: The overlapping edges of some of these flat tiles are chipped. Of concern also is that the original drainage system has been altered. Many of the original drainage holes have been covered over.

The terra cotta ring immediately adjacent to the dome was not investigated. Based upon earlier reports, this terra cotta may be in poor condition, with documented cracking, spalling and joint failure much more severe than that seen below. This area is probably more vulnerable to deterioration because it is more exposed to

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weather, and also because of its adjacency to the copper roofing. Runoff from this material, if it reached the anchorage through cracks or damaged mortar joints, could, through electrolysis, accelerate corrosion in the cast iron or steel anchors.

### 3) Recommendations

Prior to making repairs, develop a detailed investigation plan. Such a plan should include a unit-by-unit survey during which all damage is identified and mapped on large-scale drawings. During the investigation, units would be visually scrutinized, as well as sounded with a wooden mallet to identify internal damage. Selected units might be removed at this time to investigate anchorage, and to perform laboratory analysis on both the terra cotta and mortar. This information is crucial, especially if any replacement units are required. As an alternative to removal, if the units are not back-filled with grout, it may be possible to perform non-destructive anchorage investigation using a fiber-optic boroscope. Rather than removing the unit, the boroscope is inserted through a small hole.

Once all the damage is mapped, damage patterns are likely to emerge and causes to become more obvious. Construction documents may then be prepared that address both deterioration and underlying causes. A terra cotta repair plan for this building is likely to include the following:

- a) Address any underlying problems, such as poor drainage, that may be causing or contributing to terra cotta deterioration.
- b) Clean the terra cotta, using the gentlest means possible. Especially address the sealant patches at the balustrade cap, which may require specialized treatment to remove.
- c) Coat minor spalls, and areas of missing or debonded glaze, with breathable masonry coating to match the terra cotta glaze.
- d) Fill larger spalls and cracks with appropriate patching compound, such as Jahn restoration mortar formulated for terra cotta. Verify with a structural engineer any large patches that may require pinning. Coat repairs to match glaze as described above.
- e) Replace any severely damaged units in kind. Choose an acceptable manufacturer experienced in terra cotta replacement. Match ornamental pattern, configuration, color, texture and glaze. Match physical properties, based upon results of laboratory tests. Provide non-corrosive stainless steel or non-ferrous metal anchors and fastening.
- f) Remove recently applied grey caulking. Repoint all cracked or failed mortar joints. Match color, texture, and physical properties of the original mortar (unless those properties are determined to be exacerbating deterioration).

Regarding the installation of new terra cotta in lieu of existing plastered surfaces, a structural consideration makes the idea of installing a terra cotta veneer feasible. Engineers recommend strengthening the dome due to the weakness in structural continuity caused by its large number of window penetrations both in the drum and in the dome. The proposed solution calls for the addition of a 6" reinforced concrete "veneer" on the exterior of the existing dome wall. This will necessitate removing the existing "Synergy" stucco on the drum wall, as well as moving the existing tall window units and surrounding trim 6" further out so as to retain their historical relationships with the new exterior wall plane. The new concrete "veneer" will provide a uniform surface for applying new terra cotta units.

From the public view below, no one will be able to perceive the difference in the 6" thickened wall. Nor will the terra cotta, windows and trim look any different than they would have had they been applied to the existing wall. Since both structural and preservation objectives are well satisfied by this approach, we see no offsetting disadvantage which might negate this proposed solution. It is recommended that new, matching terra cotta be applied to the areas of the dome originally intended for terra cotta but changed late in the construction process to scored plaster.

## E. PLASTER

### 1) Background

In order to reduce the weight of the drum and dome, and perhaps also to save on the cost of additional masonry, the Capitol's designer elected to build the drum and dome, and its colonnade, balustrades, cupola and other details, in plaster, terra cotta and metal rather than in granite. Although these lighter, less expensive materials were used, Kletting clearly wanted the drum and dome to look like the granite masonry on the main part of the building below. Kletting's final sectional drawing of the dome called for the columns and exterior walls to be "cement plaster to match the finish of the granite stone below." Whether this was done successfully is not presently known. A matching granite finish may either have been found impossible to achieve, and/or, for cost reasons, changed to the plain, beige coating which underlies the present newer coating. In either event, the plaster eventually succumbed to damage and leakage, and also became unsightly.

In 1994-95 Utah Tile and Roofing installed a new synthetic stucco called Synergy, a product distributed by the Berger Company. In addition, a silicone-based sealant was applied. According to Andy Seppi, the applicator for Utah Tile and Roofing, the previous finish on the columns and round walls of the drum was a uniform beige color coating of asbestos and horse hair. It was badly worn, flaking and peeling in places and, due to leaking, some of the material was entering the interior of the building.

### 2) Analysis

The plain, beige finish may not have been the original finish. In any event, the surface in 1994 was in a very poor, highly deteriorated condition and getting worse each year. Moreover, the surface material was leaking into the building causing damage and a potential safety hazard. The state (DFCM), in consultation with the contractor and subcontractor, decided to repair the damage by coating the columns and walls with the Synergy product. When originally applied, it was uniformly white. Unfortunately, the silicone coating is sticky and attracts air-born pollution and particulate matter, which readily adheres to the underlying "oatmeal" texture of the plaster, giving the surface its present unsightly mottled, dirty appearance.

The new coating is adhering extremely well. Our tests on a 1995 test panel of Synergy show that two products are capable of removing the coating. The first, Pro Stripper II by Parks, once applied, dissolves the surface coat in about 20 minutes. However, because it is applied in liquid gel form, it has trouble adhering to vertical surfaces long enough to complete the dissolution process. The second product, Enviro Strip #1 by EnviroKlean, adheres well, having the consistency of peanut butter, but takes about an hour and forty minutes to dissolve the outer coat. In both instances, they leave a thin underlying coat undissolved. The process must be repeated to dissolve the second coat down to the damaged, beige coating.



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The undersides or soffits of the large, exterior entablatures appear to have been plastered, and the plaster is badly stained. The stains may be from water-born pollution or from rusting reinforcing metal contained in the beams, or both. Similar conditions exist in the plastered exterior ceilings of the recessed areas behind the colonnades. The plastered walls of the large east and west skylights are in poor condition and require repair or replacement.

### 3) Recommendations

Tests should be conducted on actual walls and columns to determine the success of the dissolving products in situ. Once the Synergy is removed, the damaged, beige undercoating also should be removed down to the underlying original finish. No tests have been conducted to date on the beige coating.

As discussed in the previous section on terra cotta, we recommend that a 6" structural concrete veneer be applied to the drum walls, and that the areas of the drum originally intended to be finished in terra cotta, but later finished with scored plaster, be covered with a terra cotta veneer of matching "imitation granite" finish, as originally intended. All sub-standard conditions such as leaking areas or areas needing improved flashing, caulking or other repairs, also should be improved.

Test the stains on the soffits of the entablatures and exterior ceilings. If pollution only, clean or replaster the surfaces. If from rusting metal, repair the cause of water leakage and repair the structural damage to the interior beams or other rusting metal elements. If the walls of the large roof-mounted skylight are retained, repair the plaster to match the original appearance.

## F. METALS

### 1) Background

Exterior metals include, in addition to the aluminum entry doors and exterior windows, cuprous (copper-based) light fixtures and railings, ferrous metal gates, and copper cladding at the dome and cupola.

Main entry doors, at the south elevation, are yellow-surfaced hollow metal. Scratches in the yellow surface reveal a darker metal below, held together by many mechanical fasteners. These doors evidently are plated, possibly brass onto a bronze or ferrous metal substrate. Secondary entries (north, east and west), feature older, possibly original aluminum doors and frames. All exterior windows are non-original aluminum replacements. Original windows were wood.

Cuprous lantern sconces, mounted to the building wall, appear at all entries. In addition, all entry approaches feature free-standing cuprous lighting standards.

A wind storm in about 1980 damaged the dome. McCullough Construction applied new copper cladding to the dome at that time, copying details from the original. The metal, pointed cupola stands atop the dome, ringed by a copper-clad balustrade and topped by a smaller, copper-clad dome.

### 2) Analysis

The exterior metal in the worst condition is that forming the entry doors, which display numerous surface cracks, particularly in the area around the hardware.

At the west entry, rust staining was observed at the granite where the cuprous railing attaches to the granite. The rust staining may be the result of galvanic corrosion between the cuprous railing and the elemental iron in the granite.

The sheet-copper dome appears to be in good condition. It has patinated green at the top, and brown at the lower surface. At the cupola, solder joints display orange rust.

### 3) Recommendations

Entry doors: Analyze the metal spectroscopically to determine composition. Both the surface and substrate should be studied. At the same time, research the original construction documents to verify that the existing finish is the original. The likely repair would involve dismantling the doors and re-plating the worst areas.

Cupola: Investigate solder to determine cause of corrosion. Does the solder have a ferrous component, or is rust bleeding through at the solder joints from ferrous material beneath? A sample of the solder should be removed for laboratory analysis to determine composition. The orange rust stains at the cupola should be removed, along with the offending solder. If ferrous underlayment or underlying fasteners are the issue, the ferrous material should be isolated from the copper, and kept dry.

Roof: Continue to monitor and provide cyclical maintenance of the roof, examining for loosening joints, leaking and corrosion. The ongoing change in coloration, or patinization, is a natural process that should be allowed to continue unimpeded.

Hardware: All exterior entry doors feature original hardware. At the south, main-entry doors, are copper-colored assemblies of scallop-cornered backplates, pulls and thumb latches (roll 1, photo 23). All other entry doors feature aluminum hardware, consisting of 4" wide by 23" high back plates, with a hammered finish within a 1/4" raised edge. Pulls with fluted ends mount to each plate (Roll 1, photo 4). All exterior hardware should be repaired and put in operable condition, and cleaned with appropriate solutions. Missing, broken or altered pieces should be repaired in-kind. Original finishes should be determined and restored.

## G. WOOD

### 1) Background

It was the architect's intention to design a "fire-proof" building insofar as possible. To that end, he used very little wood in the building. The only exception on the exterior are the two bands of wood windows in the dome. These windows are discussed below in the Windows & Glass section.

### 2) Analysis

Not Applicable

### 3) Recommendations

It is advisable to remain consistent with the original design intent and not introduce new wooden materials in the Capitol exterior during renovation/restoration.

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## H. SKYLIGHTS

### 1) Background

The skylight systems consist of both exterior and interior assemblies. The exterior skylight systems are large gable roofs on low walls on the west wing, the east wing, and over the Senate Chamber. The interior skylights above the atriums are large, open barrel vaults. The other interior skylights are flat and sit on the attic floors above three main chambers: the House of Representatives, the Senate Chamber, and the Supreme Court. Wired “Florentine” glass was used to prevent broken glass from falling into the space below.

### 2) Analysis

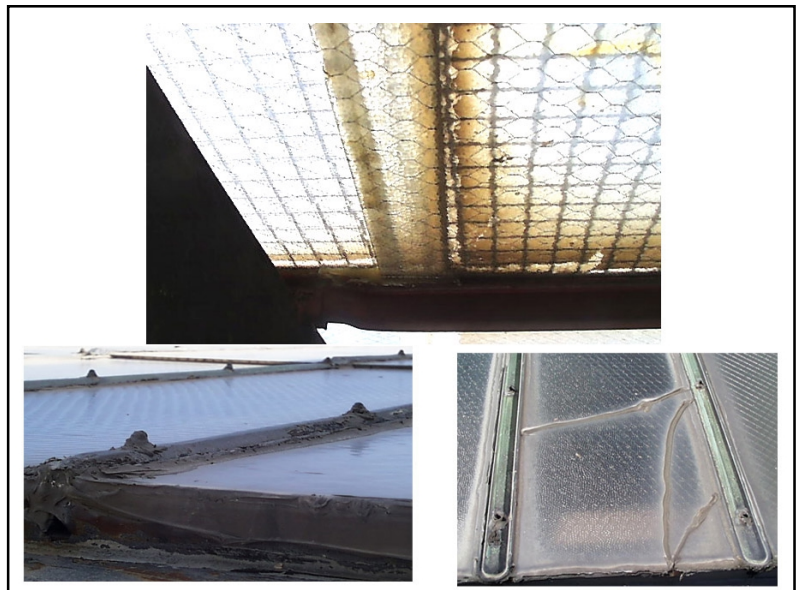
- a) Glass: Because it is difficult to find Florentine-style, honeycomb-wired glass today, many broken panes have been replaced with modern light green wired safety glass. Regrettably, those modern panes do not match the original color and wire pattern. Although most of the skylight glass is wired, there are also 84 panels of decorative stained glass in the House of Representatives.
- b) Structural System: The skylights are supported by a steel truss system. 50-foot-span trusses carry the skylight load down to columns below. Although this structural system appears to be adequate under normal static loading, it is probable that the large atrium opening may suffer severely from torsion in the event of an earthquake.

A July 2000 comment from Reaveley Engineers & Associates Inc., addressed this issue:

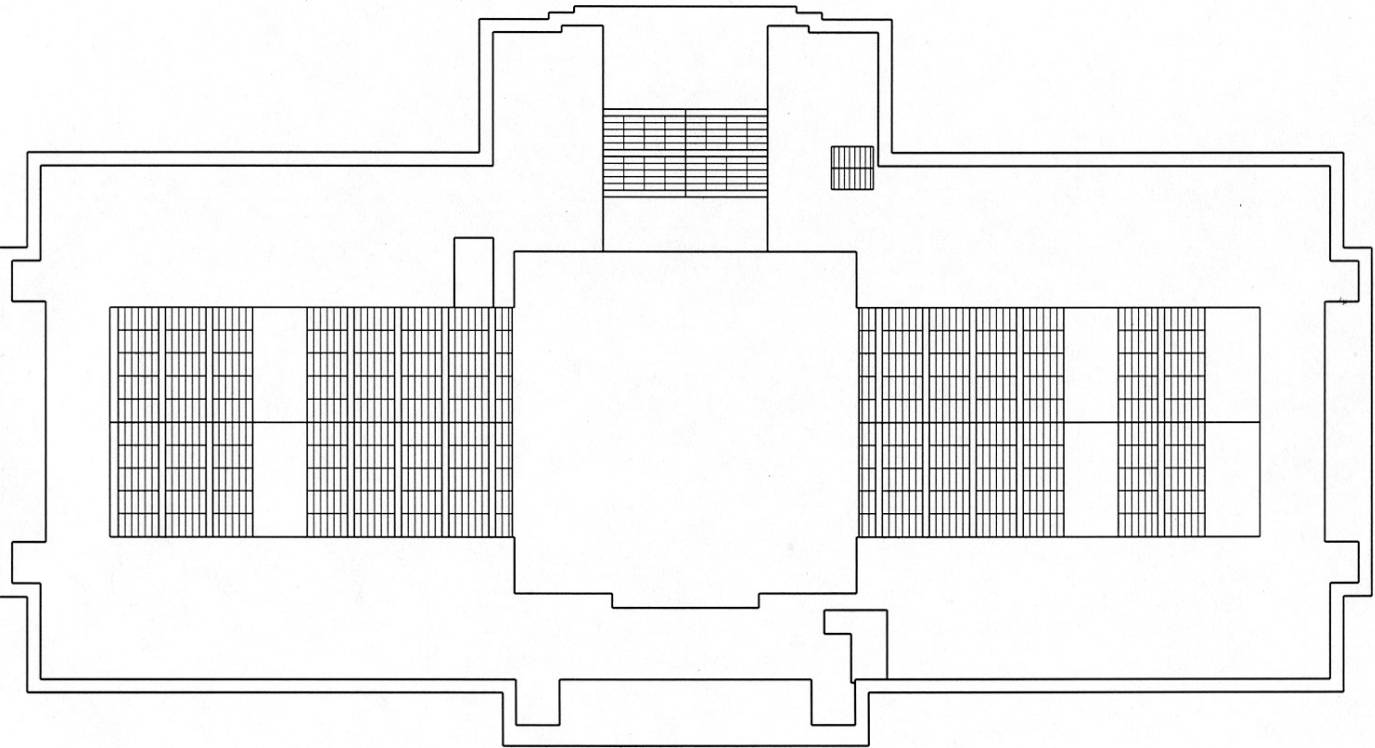
*“Although the skylight appears to behave well under normal everyday service loads, there is serious concern regarding the potential damage and falling debris that could occur as the result of seismic activity. Since there are large diaphragm openings at this level of the structure, the skylight infills could rack, which means that they would be forced to deform in an oblique manner. If this were to happen, the bond between the glass panes and the steel bars could break and large pieces or perhaps entire panes of glass could fall and injure occupants below.”*

In Reaveley’s 1993 Seismic Retrofit Study, bracing and additional anchorage of the large section of skylights were suggested over the interior space and over the three main assembly chambers.

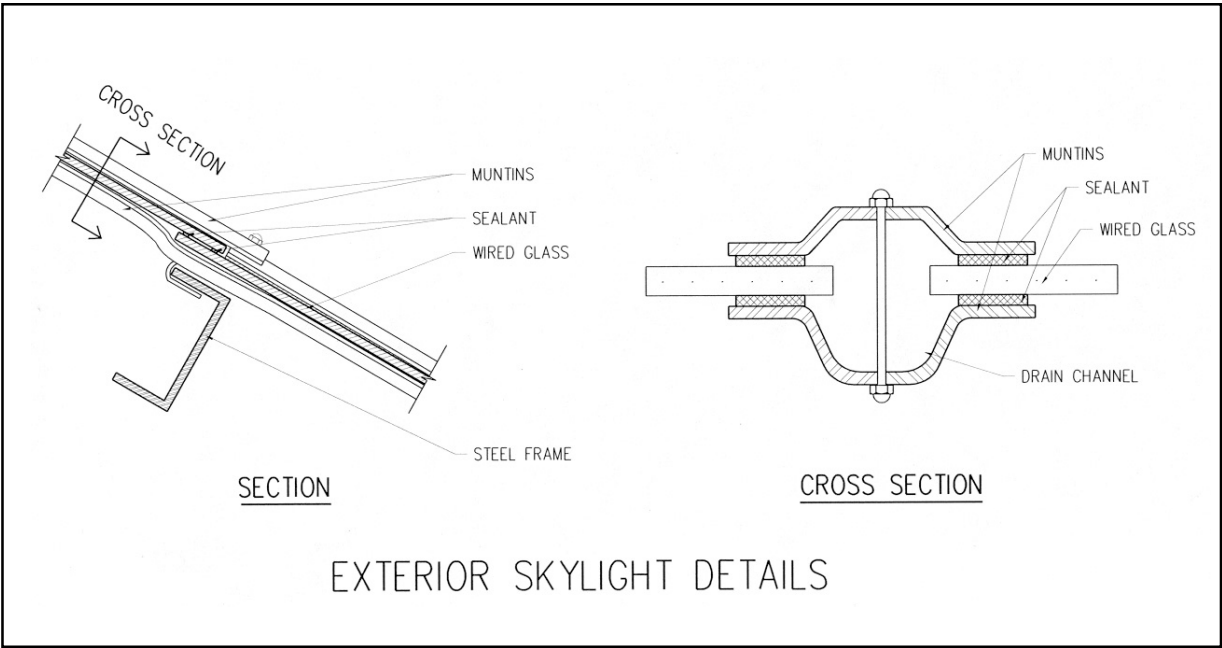
- c) Exterior Skylight System: The wired glass panels overlap one another with caulking at the seams to prevent water infiltration. The upper muntins and lower muntins then sandwich wired glass with







EXTERIOR SKYLIGHT PLAN



EXTERIOR SKYLIGHT DETAILS

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sealant. The muntins also drain water away from the skylight system, if water were to penetrate through the sealant.

Like much of the rest of the capitol building, the skylight systems are 85 years old, and are showing the effects of age. More than ten percent of the wired glass is cracked or broken, and in many places caulking is missing or damaged. Damaged joints allow water to penetrate and damage structural members in the attic below, and they also allow weathering to deteriorate their own internal structure. There are many potentially contributing factors to the damage of the glass. Some glass is broken on impact when ice falls from the dome above, or when the wind is strong enough to throw foreign objects against the structure. Large falling chunks of ice can be avoided with a roof-heating system that would melt away snow and ice as it precipitates rather than allowing it to accumulate until it fails under its own weight. Such a system would also protect the terra cotta ornaments and balustrades, which show a considerable amount of breakage from the same source.

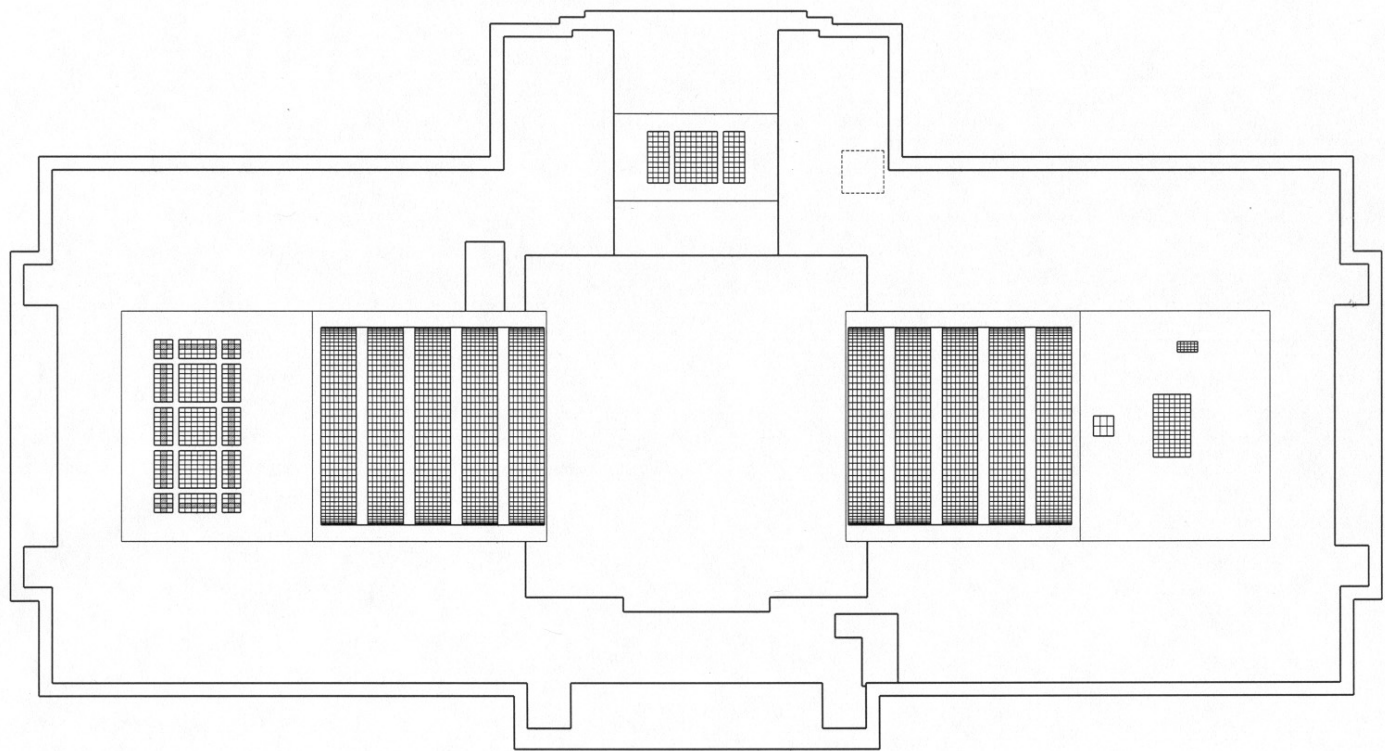
Cracks in skylight glass may also be a result of unevenly distributed stress. This may be caused by poor installation, varying densities of the glass itself, or uneven sunlight. If a single pane is heated on one side by direct sunlight while the other side remains in the shade, the varying expansions can cause critical stresses.

A 13'x 13' exterior skylight is located east of the Senate Chamber without any evidence of the light well that helped to illuminate the old art gallery. The space on the fourth floor is now being used as storage for the printing office.

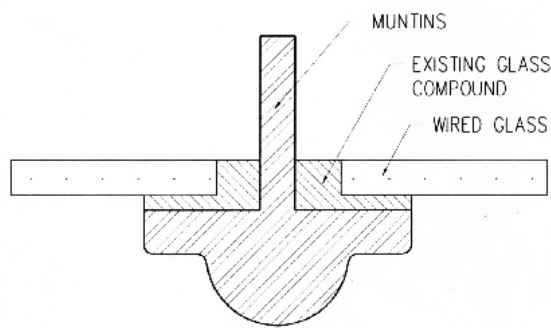
d) Interior Skylight System: The interior skylight glasses are cut to fit in a grid of metal muntins sealed airtight with glass compound. This is structurally sufficient for normal loads, but could not resist seismic forces. The muntins and mullions would rack and deform under seismic loads, and that deformation would undoubtedly break the skylight glasses. In modern mounting technology, there is a space designed between muntins and glass. Glass could float between muntins during seismic activity.

Artificial light fixtures are currently blocking daylight from penetrating skylights in the House of Representatives. These fluorescent lights were introduced to provide the House of Representatives with sufficient lighting day and night. It is inhibiting to natural lighting to retain these fixtures.

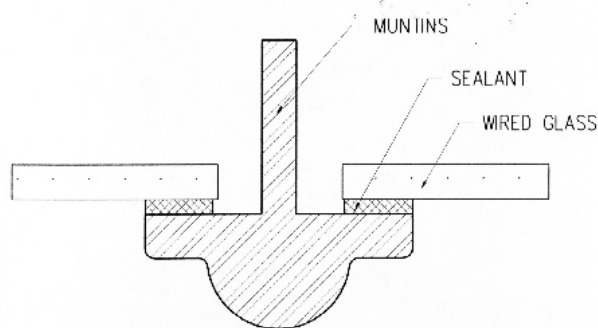
The attic above the Supreme Court is unclean and unkempt. The butt insulation covering the attic floor has rotted and at one point covers a 3'x 6' skylight. This is one of several small skylights indicated on the 1916 plans surrounding the Supreme Court Chamber. The interior skylight glass above the Supreme Court Chamber has been entirely replaced by fiberglass and is not sealed airtight. The thin fiberglass does nothing to protect the space below from falling objects.



EXISTING INTERIOR SKYLIGHT PLAN



EXISTING DETAIL



SUGGESTED DETAIL  
ALLOWING MOVEMENT DURING SEISMIC DEFORMATION

INTERIOR SKYLIGHT DETAILS

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### 3) Recommendations

A June, 1998 evaluation of the skylights concluded that,

*“The large, gable shaped exterior skylights were technically advanced for 1916 and have done a remarkably good job of preventing water infiltration to the public space below. By today’s standard, however, they are obsolete and seismically hazardous. Their design relies on asphalt for continued water proofing and the wire-glass panels will break and fall into the space below in the event of an earthquake. The exterior skylight should be entirely replaced with a modern skylight system.”*

### 4) Three Skylight System Renovation Options

- a) Replace Interior System/Replace Exterior System: Replace the existing skylight system with a new skylight system that is capable of large, racking type deformation without failure due to seismic activity. New interior glass must be translucent, tempered, laminated, and matching the color of the original glass. The new exterior skylight system must match the color, pattern, and transparency ratio of the existing system. This is the most expensive option.
- b) Restore Interior Glass/ Replace Exterior System: Restore the glass of the existing interior skylight with matching or original wired glass that can be salvaged from the exterior skylight system. The exterior skylight system should be a newly constructed, seismically designed skylight system that must match the color, pattern, and transparency ratio of the existing system. This option is of moderate expense.
- c) Restore Interior Glass/ Restore Exterior Glass: Restore the existing wire glass at the interior skylight system and the exterior skylight system with similar wired glass. Upgrade the existing structural systems in place. This is, by a slight amount, the least expensive option.

The first proposal costs more and may not retain the historic appearance of the original skylight. The third proposal preserves original historic expression, but retains a skylight system obsolete and considered unsafe. We recommend the second proposal. It is economical and restores the historic integrity of the skylight system. The modern exterior skylight system may be easily maintained and will provide good protection for the interior skylight system and the space below. The interior glass also should be restored with original honeycomb wired glass.

### 5) Related Recommendations:

- \* We recommend restoring the light well east of the Senate Chamber regardless of the future functions assigned to this space.
- \* We recommend the removal of the fluorescent lights above the skylight in the interests of energy conservation and historic integrity. Light-sensitive fixtures could be installed surrounding the interior skylight to operate only during evenings and cloudy days.
- \* We recommend restoring the small skylights surrounding the Supreme Court Chamber as indicated on the original plans.

### Quantity of Skylight Glass of Utah State Capitol

## EXTERIOR SKYLIGHT

Chamber	Size	Quantity	Type
Atrium	7'-0" x 1'-9 3/4 "	520	wired glass
	7'-0" x 11"	20	wired glass
House of Representatives	7'-0" x 1'-9 3/4 "	180	wired glass
Supreme Court	7'-0" x 1'-9 3/4 "	120	wired glass
Senate Chamber	7'-0" x 1'-9 3/4 "	80	wired glass

## INTERIOR SKYLIGHT

Atrium	1'-6 1/2" x 1'-2"	3520	wired glass
House of Representatives	1'-6" x 1'-4 1/2"	96	wired glass
	1'-6" x 1'-2"	24	wired glass
	1'-11" x 1'-4 1/2"	144	wired glass
	1'-11" x 1'-2"	48	wired glass
	1'-6" x 1'-4 1/2"	48	stained glass
	1'-6" x 1'-2"	24	stained glass
	1'-11 x 1'-2"	12	stained glass
Supreme Court	1'-5" x 1'-2"	24	wired glass
	1'-0" x 9"	24	wired glass
	2'-10 1/2" x 1'-10 1/2"	6	wired glass
Senate Chamber	1'-6" x 1'-5"	140	wired glass

Total    5030



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## I. WINDOWS

### 1) Background

The original exterior windows were heavy-duty wood assemblies. The original architectural plans show large frames, sashes and brick moldings for all of the windows in the first four floors of the building. The window sashes opened and closed with a system of concealed pulleys, hemp rope and lead weights. The original plans call for “Florentine glass,” which was likely a high quality type of early polished plate glass.

These double-hung windows were later removed and replaced with the present double-pane, mill-finished aluminum windows. Both in the color and design, the latter are not compatible with the historic appearance of the building.

Some of the small, 2 by 4-foot openings in the basement wall once had windows. Many of these have been replaced with mechanical grills. Others have been obscured by heavy landscaping.

For the two bands of windows in the dome, wood frame units were used, both for the tall, multi-paned lower band of windows, and also for the smaller, multi-paned upper band.

### 2) Analysis

The newer metal windows are in good condition. Although they were intended to have operable sashes, they are hard to open and are rarely opened, probably for safety reasons and to keep heated or cooled air in the building.

The basement openings will continue to be modified during renovation and then entirely concealed behind the covered moats built as part of the base isolation system.

The two upper bands of windows in the dome are in relatively good condition, having been removed and renovated in Minnesota in about 1995, then reinstalled. Instead of using conventional glazing caulking to secure the glass on the exterior, thin, angular wooden strips were applied in their place. Some of these are warping and pulling away due to weathering, which is quite extreme on the dome. It is expected that these small strips will continue to become further damaged and deteriorated.

### 3) Recommendations

The basement windows and non-window openings require no attention.

The metal frame windows in the main part of the building should be removed and replaced with metal frame, double-pane, thermal break assemblies exactly matching the sectional profiles of the originals as shown in the Kletting plans. The metal should be enameled a color matching the original dark gray color. Matching metal brickmolds should be installed. Set the windows back into the opening the same distance they were originally. In short, install windows which will convey the historic appearance, but use windows that meet modern standards for construction and energy conservation.

Repair the thin wooden muntin “caulking” strips on the upper wood windows. To enhance longevity, consider installing white-enameled metal strips in lieu of the weather-vulnerable wooden ones.

A structural necessity may require a minor modification to the uppermost band of small windows just below the roof of the dome. The multiple penetrations in this area create a condition of weak seismic resistance.

Therefore the engineers recommend that every other window be filled in with reinforced concrete from the back side, leaving the exterior unchanged.

These small windows illuminate the unfinished attic space only. They do not penetrate the inner dome wall or illuminate the interior rotunda. They exist primarily as an ornamental feature, probably because windows appear in this location on other Neo-Classical state capitols. From the exterior view, they are essentially dark or blank and read as windows entirely because of their location and visible trim, sashes and muntins.

The structural solution which affects these small windows is to apply reinforced behind every other one to enhance the structural continuity and seismic-resisting capacity of the dome. Because the windows are already non-transparent, the addition of the concrete behind will not be visually noticeable provided a backing of common color is placed behind every window.

## J. DOORS AND HARDWARE

### 1) Background

The main, public exterior doors and hardware are the original, ornamental metal, double doors designed by architect Kletting. These are found on the west, east and south sides of the building. The original doors on the north side have been replaced with newer units. In addition, some newer, single metal slab security doors have been added to lower, northern openings. See the Metal section (e.) for a discussion of treatments of the metal doors.

### 2) Analysis

The newer, lower northern slab doors are not architecturally compatible with the ornamental doors, but they are not used or much viewed by the public. The original ornamental doors remain functional and in good condition.

### 3) Recommendations

We recommend preservation of the original ornamental metal doors wherever they remain. Where they have been replaced with newer, less compatible units, we recommend replacement of these with metal doors matching the originals. The newer slab doors in the north elevations should be replaced with more ornamental paneled metal doors since they are now incompatible and may be more visible once an Annex is built to the north.

## K. ROOFING

### 1) Background

The original roofing over the main, “flat” rectangular block of the building has been repaired and covered over with new roofing several times in the past 85 years. This was necessary because of roof leaks which caused some interior damage and also allowed water to penetrate the stone masonry and concrete, causing the corrosion of an unknown amount of metal connectors and reinforcing bars. The most recent reroofing was done c. 1990 as part of a larger exterior renovation effort. Prior to this work, the existing roofing was

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described as in “very bad shape.”

The newest roofing project entailed removing the existing roofing down to the concrete, then installing 1-1/2" Perelite/FESCO board, then a four-ply built-up membrane about 5/8" thick, then an 1/8" thick asphalt coating, and finally Johns-Mansville aluminum paint on top of the asphalt coating.

The original copper roof covering the dome was largely blown off during a severe wind storm in about 1980. A new, matching copper roof was installed by McCullough Construction as soon as possible. The dome roof had previously been prone to leaking and damaging the plaster ceiling and painted wall murals below. In 1965 the state paid to have “200 holes” patched in the dome roof.

The small areas of roofing on the three narrow, circular promenades on the dome have been covered with rubber-based membranes. During the recent re-roofings, new metal or rubber-based flashing also was installed and some new drains were installed. Some old drains, including drainage holes in the sidewalls of balustrade curbs, were abandoned or filled in.

## 2) Analysis

Following the tornado of 1999, Andy Seppi of Utah Roofing and Tile examined the Capitol’s roofs. He found no damage, nor has any leaking been reported since that event. Fairly deep cracks are visible in many areas of the large, flat roofing. The cracks are only in the upper asphalt coating, however, and do not penetrate the underlying 4-ply membrane.

## 3) Recommendations

Following the tornado of 1999, Andy Seppi of Utah Roofing and Tile examined the Capitol’s roofs. He found no damage, nor has any leaking been reported since that event. In nearly all of the places examined, the roofing appears to be in very good condition. We recommend regular inspections and a program of cyclical maintenance to safeguard against future leaking problems.

# L. CAULKING

## Comments

During the repairs of the 1990s, mastic caulking was extensively used to fill and cover cracks and gaps in a variety of materials including stone, terra cotta, plaster, metal, wood and glass. In many places the caulking was installed properly. In others, such as on the face of terra cotta pieces, the caulking was smeared on as a temporary, stop-gap solution to deter further water damage. In these locations, however, the caulking was never replaced with proper joint sealers. The terra cotta is not only unsightly, it is not a breathable material and traps moisture behind it, potentially causing further widening or cracking of joints. The same conditions apply where stone has been caulked rather than mortared in its joints. We recommend that a caulking and mortar specialist examine existing caulking and specify compatible replacement materials such as conventional mortar of the mixture used in 1916.

